RETEC Standard Operating Procedure 110 (SOP)

Packing and Shipping Samples

1.0 Purpose And Applicability

The RETEC Group, Inc. (RETEC) Standard Operating Procedure (SOP) 110 describes proper packaging methods and shipment of samples to minimize the potential for sample breakage, leakage, or cross contamination, and provide a clear record of sample custody from collection to analysis. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

The EPA RCRA regulations (40 CFR Section 261.4 [d]) specify that samples of solid waste, water, soil, or air collected for the purpose of testing are exempt from regulation when any of the following conditions apply:

- Samples are being transported to a laboratory for analysis
- Samples are being transported to the collector from the laboratory after analysis
- Samples are being stored:
    - By the collector prior to shipment for analyses
    - By the analytical laboratory prior to analyses
    - By the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case

Samples collected by RETEC are generally qualified for these exemptions. RETEC SOP 110 deals only with these sample types.

2.0 Responsibilities

The field sampling coordinator is responsible for the enactment and completion of the chain-of-custody, and the packaging and shipping requirements outlined here and in project-specific sampling plans.

3.0 Supporting Materials

The following materials must be on hand and in sufficient quantity to ensure that proper packing and shipping methods and procedures may be followed:

- Chain-of-custody forms and tape

- Sample container labels
- Coolers or similar shipping containers
- Duct tape or transparent packaging tape
- Zip-lock type bags
- Protective wrapping and packaging materials
- Ice or cold packs
- Shipping labels for the exterior of the ice chest
- Transportation carrier forms (Federal Express, Airborne, etc.)

4.0 Methods And Procedures

All samples must be packaged so that they do not leak, break, vaporize, or cause cross-contamination of other samples. Waste samples and environmental samples (e.g., groundwater, soil, etc.) should not be placed in the same container. Each individual sample must be properly labeled and identified. Each shipping container must be accompanied by a chain-of-custody record. When refrigeration is required for sample preservation, samples must be kept cool during the time between collection and final packaging.

All samples must be clearly identified immediately upon collection. Each sample bottle label (Figure 1) will include the following information:

- Client or project name, or unique identifier, if confidential
- A unique sample description
- Sample collection date and time
- Sampler's name or initials
- Indication of filtering or addition of preservative, if applicable
- Analyses to be performed

After collection, identification, and preservation (if necessary), the samples will be maintained under chain-of-custody procedures as described below.

4.1 Chain-Of-Custody

A sample is considered to be under custody if it is in one's possession, view, or in a designated secure area. Transfers of sample custody must be documented by chain-of-custody forms (Figure 2). The chain-of-custody record will include, at a minimum, the following information:

- Client or project name, or unique identifier, if confidential
- Sample collector's name
- Company's (RETEC) mailing address and telephone number
- Designated recipient of data (name and telephone number)
- Analytical laboratory's name and city
- Description of each sample (i.e., unique identifier and matrix)
- Date and time of collection

- Quantity of each sample or number of containers
- Type of analysis required
- Date and method of shipment

Additional information may include type of sample containers, shipping identification air bill numbers, etc.

When transferring custody, both the individual(s) relinquishing custody of samples and the individual(s) receiving custody of samples will sign, date, and note the time on the form. If samples are to leave the collector's possession for shipment to the laboratory, the subsequent packaging procedures will be followed.

4.2 Packing for Shipment

To prepare a cooler for shipment, the sample bottles should be inventoried and logged on the chain-of-custody form. At least one layer of protective material should be placed in the bottom of the container. As each sample bottle is logged on the chain-of-custody form, it should be wrapped with protective material (e.g., bubble wrap, matting, plastic gridding, or similar material) to prevent breakage. Each sample bottle should be placed upright in the shipping container. Each sample bottle cap should be checked during wrapping and tightened if needed. Avoid over tightening, which may cause bottle cap to crack and allow leakage. Additional packaging material such as bubble wrap or styrofoam pellets should be spread throughout the voids between the sample bottles.

Most samples require refrigeration as a minimum preservative. Reusable cold packs or ice placed in heavy duty zip-lock type bags should be distributed over the top of the samples. Two

or more cold packs or bags should be used. Additional packing material should then be placed to fill the balance of the cooler or container.

Place the original completed chain-of-custody record in a zip-lock type plastic bag and place the bag on the top of the contents within the cooler or shipping container. Alternatively, the bag may be taped to the underside of the container lid. Retain a copy of the chain-of-custody record with the field records.

Close the top or lid of the cooler or shipping container and rotate/shake the container to verify that the contents are packed so that they do not move. Add additional packaging if needed and reclose. Place signed and dated chain-of-custody seal (Figure 3) at two different locations (front and back) on the cooler or container lid and overlap with transparent packaging tape. The chain-of-custody tape should be placed on the container in such a way that opening the container will destroy the tape. Packaging tape should encircle each end of the cooler at the hinges.

Sample shipment should be sent via an overnight express service that can guarantee 24-hour delivery. Retain copies of all shipment records as provided by the shipper.

5.0 Quality Assurance/Quality Control

Recipient of sample container should advise shipper and/or transporter immediately of any damage to container, breakage of contents, or evidence of tampering.

6.0 Documentation

The documentation for support of proper packaging and shipment will include RETEC or the laboratory chain-of-custody records and transportation carrier's airbill or delivery invoice. All documentation will be retained in the project files.

Sample Label

ThermoRetec Corporation
23 Old Town Square, Suite 250
Fort Collins, CO 80524-2473
www.thermoretec.com
(970) 493-3700 Phone
(970) 493-2328 Fax

ThermoRetec
Smart Solutions. Positive Outcomes.

Sample I.D.______________________________

Location________________________________

Date____________ Time_______ Sampled By_______

Test(s)_________________________________

Pres___________________________________

Figure 1

Chain of Custody Record № 1800

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(970) 493-3700 Phone • (970) 493-2328 Fax
www.thermoretec.com

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Project Name:	Project Number:
Send Report To:	Sampler (Print Name):
Address:	Sampler (Print Name):
	Shipment Method:
	Airbill Number:
Phone:	Laboratory Receiving:
Fax:	

Analysis Requested

Page_____of_____

Purchase Order #:______________________

Field Sample ID	Sample Date	Sample Time	Sample Matrix	Number of Containers												Comments, Special Instructions, etc.	Lab Sample ID (to be completed by lab)

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Sample Custodian Remarks (Completed By Laboratory):

QA/QC Level	Turnaround	Sample Receipt	
		Total # Containers Received?	
Level I ☐	Routine ☐	COC Seals Present?	
Level II ☐	24 Hour ☐	COC Seals Intact?	
Level III ☐	1 Week ☐	Received Containers Intact?	
Other ☐	Other ______	Temperature?	

White: Lab Copy   Yellow: PM Copy   Pink: Field Copy   Gold: PM/QA/QC Copy

Figure 2

Chain of Custody Seal

Custody Seal

Date ______________________________

Signature ______________________________

Seal No. ______________________________

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Figure 3

RETEC Standard Operating Procedure (SOP) 120 Decontamination

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 120 describes the methods to be used for the decontamination of items which may become contaminated during field operations. Decontamination is performed as a quality assurance measure and as a safety precaution. It prevents cross-contamination between samples and also helps maintain a clean working environment. Equipment requiring decontamination may include hand tools, monitoring and testing equipment, personal protective equipment, or heavy equipment (e.g., loaders, backhoes, drill rigs, etc.).

Decontamination is achieved mainly by rinsing with liquids which may include: soap and/or detergent solutions, tap water, distilled water, and methanol. Equipment may be allowed to air dry after being cleaned or may be wiped dry with paper towels or chemical-free cloths.

All sampling equipment will be decontaminated prior to use and between each sample collection point. Waste products produced by the decontamination procedures such as rinse liquids, solids, rags, gloves, etc. will be collected and disposed of properly based on the nature of contamination and site protocols. Any materials and equipment which will be reused must be decontaminated or properly protected before being taken off site.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

It is the responsibility of the field sampling coordinator to ensure that proper decontamination procedures are followed and that all waste materials produced by decontamination are properly managed. It is the responsibility of any subcontractors (e.g., drilling or sampling contractors) to follow the proper designated decontamination procedures that are stated in their contracts and outlined in the project health and safety plan. It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that no contaminants are negligently introduced into the environment.

3.0 Supporting Materials

The following materials should be on hand in sufficient quantity to ensure that proper decontamination methods and procedures may be followed:

- Cleaning liquids and dispensers (soap and/or detergent solutions, tap water, distilled water, methanol, or isopropyl, etc.)
- Personal safety gear, as defined in the project health and safety plan
- Paper towels or chemical-free cloths
- Disposable gloves
- Waste-storage containers (e.g., drums, boxes, plastic bags)
- Drum labels, if necessary
- Cleaning containers (e.g., plastic and/or galvanized steel pans or buckets)
- Cleaning brushes
- Plastic sheeting

4.0 Methods and Procedures

The extent of known contamination will determine the degree of decontamination required. When the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated.

Standard operating procedures listed below describe the method for full field decontamination. If different technical procedures are required for a specific project, they will be spelled out in the project plans.

Such variations in decontamination may include all or an expanded scope of these decontamination procedures:

- Remove gross contamination from the equipment by brushing and then rinse with tap water.
- Wash with detergent or soap solution (e.g., Alconox and tap water).
- Rinse with tap water.
- Rinse with methanol or isopropyl.
- Rinse with distilled water.
- Repeat entire procedure or any parts of the procedure as necessary.
- After decontamination procedure is completed, avoid placing equipment directly on ground surface to avoid re-contamination.

Downhole drilling equipment, such as augers, split spoons, Shelby tubes, and sandlines, will be decontaminated with pressurized hot water or steam wash, followed by a fresh water rinse.

No additional decontamination procedures will be required if the equipment appears to be visually clean. If contamination is visible after hot water/steam cleaning, then a detergent wash solution with brushes (if necessary) will be used.

5.0 Quality Assurance/Quality Control

To assess the adequacy of decontamination procedures, rinsate blanks should be collected and analyzed for the same parameters as the field samples. Specific number of blanks will be defined in the project specific sampling plan. In general, one rinsate blank will be collected per ten samples.

6.0 Documentation

Field notes describing procedures used to decontaminate equipment/personnel and for collection of the rinsate blanks will be documented by on-site personnel. Field notes will be retained in the project files.

RETEC Standard Operating Procedure (SOP) 210 Soil Sample Collection

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 210 describes methods used to obtain soil samples for physical testing, stratigraphic correlations, and chemical analysis. Soil samples are obtained in conjunction with surface sampling, test pit excavation, soil boring, and monitoring well installation programs. These procedures provide specific information for determining the physical makeup of the surface and subsurface environment, as well as how to estimate the extent and magnitude of soil contamination, if present. RETEC SOP 210 will discuss sampling of the surface material with hand tools and sampling of the subsurface material by augers and split spoons, and within test pits by backhoes and hand tools.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, Job Hazard Analysis, Safety Task Analysis Review, or Site-Specific Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The project geologist/engineer will be responsible for the proper use and maintenance of all types of equipment used for obtaining soil samples. The geologist/engineer will determine the location, total depth, and overall size of each surface sample collection point and test pit, and the location and depth of all subsurface borings based on the project specific sampling plan. The project geologist/engineer will be responsible for locating any subsurface utilities or structures, and disseminating this information to the contractor prior to commencing the sampling program. The location of overhead utilities and obstructions relative to the sampling locations will also be noted. In addition, a Safety Task Analysis Review will be conducted to assess any other potential health and safety hazards associated with soil sample collection.

It shall be the responsibility of the project geologist/engineer to observe all activities pertaining to soil sampling and subsurface investigations to ensure that all the standard procedures are followed properly, and to record all pertinent data on a field log or field book. The collection, handling, and storage of all samples will be the responsibility of the geologist/engineer.

It is the responsibility of the contractor to provide safe and well-maintained equipment for obtaining subsurface samples in borings and for decontamination of the equipment. Test pit construction, split-spoon sampling, and subsurface augering will be conducted by the contractor. In addition, the contractor will be responsible for containment of cuttings, if required.

3.0 Health and Safety

This section presents the generic hazards associated with soil sampling techniques and is intended to provide general guidance in preparing site-specific health and safety documents. The Site-Specific Health & Safety Plan, Job Hazard Analyses, and Safety Task Analysis Reviews will address additional requirements and will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

Test Pit Excavation

- Heavy equipment operation
- Cave-in (trench/excavation work)
- Hazardous materials (exposure and/or release)
- Utilities (underground)
- High noise levels
- Air quality (i.e., chemical, dust, explosive conditions)
- Uneven walking/working surfaces

Hollow Stem Auger Drilling

- Heavy equipment operation
- Pinch points
- Rotating parts
- Loose clothing
- Heavy lifting
- Air quality (i.e., chemical, dust, explosive conditions)
- Hazardous materials (exposure and release)
- Pressurized lines
- High noise levels
- Utilities (underground or overhead)
- Hoisting
- Overhead hazards
- Hand hazards

Rotary Drilling (Mud/Air)

- Same as above
- Increased noise hazard
- Increased dust hazard (air rotary)
- Cyclones/Diverters (pressurized lines should be anchored with whip-stops)
- Investigation derived waste containment

- Blow protect inspection/replacement
- Sample collection (i.e., there are increased hazards when taking samples from air rotary rigs resulting from overhead hazards (cyclones), pressurized lines, increased noise, and air quality at sample collection outlets. Field personnel must be aware of these hazards and initiate engineered controls to limit these hazards.)

If site/project conditions warrant the use of other drilling techniques, hazards associated with these techniques will be evaluated by amendment in the site-specific Health & Safety Plan, Job Hazard Analyses, or Safety Task Analysis Reviews. Drill rig inspections, if applicable, will be completed prior to initiating soil sampling.

4.0 Supporting Materials

In addition to materials provided by the contractor, the geologist/engineer will provide:

- Sample bottles/containers and labels
- Boring or test pit logs
- Field notebook
- Chain-of-custody forms
- Depth-measurement device
- Stakes and fluorescent flagging tape
- Decontamination solution
- Camera for photographing sections
- Sampling equipment (e.g., knives, trowels, shovels, hand augers, aluminum foil, etc.)
- Plastic garbage bags
- Material Safety Data Sheets (MSDSs) for any chemicals or site specific contaminants
- A copy of the site-specific Health and Safety Plan

5.0 Methods and Procedures

Specific sampling equipment and methodology will be dictated by characteristics of the soil to be sampled, type of soil samples required, and by the analytical procedures to be employed. Soil samples obtained at the surface may be collected using a shovel, trowel, or hand auger. A hand auger can be used to extract shallow soil samples up to 10 feet below the surface. Sampling to obtain uniform coverage within a specified area will often require the use of an area grid. These considerations will be followed based upon project specific requirements.

There are two types of samples that may be required by the project sampling plan, grab or composite. A grab sample is collected from a specific location or depth and placing it in the appropriate sample container. A composite sample consists of several discrete locations (or depths) mixed to provide a homogeneous, representative sample. To ensure that the sample is representative, the soil volume and collection method from each discrete location should be as identical as possible. It should be noted that samples analyzed for volatile organic compounds cannot be composited since it is necessary to expose the soil to the atmosphere prior to transfer into the sample container.

The sampling depth interval in borings is typically one sample for every five feet with additional samples taken at the discretion of the project geologist/engineer when significant color, textural, or odor changes are encountered. Deviations in the standard operating procedure will be covered in the project specific sampling plans.

Most subsurface explorations by RETEC will be on privately owned land, often an industrial facility. Prior to commencing subsurface exploration, RETEC will work with the facility manager to locate any subsurface utilities or structures and discuss any pertinent health and safety issues. Utility companies, (electric, gas, water, phone, sewer, etc.) who may have equipment or transmission lines buried in the vicinity, will also be notified. Many regions have organizations, which represent all utilities for these notification purposes. Allow enough time after notification (typically three working days) for the utilities to respond and provide locations of any equipment, which may be buried on site. Overhead lines must also be kept in consideration when a drilling rig is used. As a rule of thumb, the rig and derrick should be at least 25 feet away from overhead lines unless special shielding and grounding are provided. In addition, consult the site-specific health and safety documentation.

5.1 General Applications

General locations shall be mapped by the field geologist/engineer using a stationary structure as the reference point. Specific locations for test pits and sampling locations will be documented by survey or by using topographic maps and/or plans. A preliminary log of the test pit, or boring shall be prepared in the field by the field geologist/engineer. A sketch of the test pit may be necessary to depict the strata encountered. Before measuring the depth to groundwater, if encountered, the field geologist/engineer will allow sufficient time for stabilization of the water table in the excavation or boring. All information shall be recorded on the field log or the field book.

5.2 Surface Sampling

Prior to surface sampling, remove all surface materials that are not to be included in the sample such as rocks, twigs, and leaves. For sample collection taken within the upper two to three feet, use a shovel or trowel. A hand auger may be used for depths of up to 10 feet. When using the hand auger, auger the hole to the required depth, then slowly remove the auger and collect the soil sample from the auger flight or auger bucket at the point corresponding to the required depth. A tube sampler can be attached to the auger rods after augering to the desired depth, inserted into the open borehole, and then advanced into the soil at the base of the boring. If sampling is in sandy or non-cohesive soil, a shovel may be necessary to collect samples. Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. The frame number and picture location shall also be documented in the field book. All equipment shall be decontaminated following RETEC SOP 120 between sample locations unless otherwise specified in the project specific sampling plan.

5.3 Test Pit Excavation and Sampling

Test pits shall be excavated in compliance with applicable safety regulations. Walls should be cut as near vertical as possible to facilitate stratigraphic logging. Field personnel will not enter an open test pit deeper than four feet without shoring or benching present. Samples shall be collected from the backhoe bucket with a trowel or from the side of the test pit wall (depending upon the depth of the test pit and the safety precautions in place). The size, depth, and orientation of the test pit shall be recorded on the test pit log (Figure 1). Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. Frame numbers and picture locations shall also be documented in the field book.

The test pit shall be inspected and the test pit log reviewed to ensure that all the appropriate and/or required data and samples have been collected. All test pits will be backfilled to original grade and compacted. All equipment shall be decontaminated following RETEC SOP 120 and guidance provided in the Health and Safety Plan between sample locations unless otherwise specified in the project specific sampling plan. Avoid using flammable liquids for decontamination purposes.

5.4 Subsurface Sampling

Note: RETEC employees conducting these operations must have completed a drilling safety course.

Borings are typically advanced by two methods: rotary drilling and augering. The casing shall be of the flush-joint or flush-couple type and of sufficient size to allow for soil sampling, coring, and/or well installation. All casing sections shall be straight and free of any obstructions. Hollow-stem augers or solid-flight augers with casing may be used according to specific project requirements. Rotary drilling with water, mud, or air may be used in dense or indurated formations to advance to the required sample depth where a split spoon sampler or a coring device will be used to obtain the sample. Re-circulated water shall not be used when casing is being driven unless specified in project specific sampling plans and/or directed and properly documented by the field geologist/engineer. If re-circulated water is used, all loose material within the casing shall be removed by washing to the required sampling depth using a minimum amount of water. Care should be taken to limit re-circulation of the wash water to those times when the water supply is extremely limited or unavailable. The amount of water used should be documented in the project field book or on the field form.

Generally subsurface soil samples shall be obtained using a split-tube type sampler (split spoon), however, other devices (Shelby tubes, continuous samples, core, etc.) may be used as specified in the project specific sampling plan. Split-spoons come in a variety of sizes with the most standard having a 2-inch OD, a 1 3/8-inch ID and a 24-inch long barrel with an 18-inch sample capacity. Split spoons shall be equipped with a check valve at the top and a flap valve or basket-type retainer at the bottom. Samples shall be obtained using the standard penetration test (SPT), which allows for qualitative determination of mechanical properties and aids in identification of material type. The number of hammer blows shall be recorded on the boring log (Figure 2) for each six-inch drive distance.

The soil sampler shall be opened immediately upon removal from the casing. If the recovery is inadequate (i.e., most of the penetrated material was not retained inside the soil sampler), a note will be made on the boring log stating that "no recovery" was possible at that depth. In the event that gravels or other material prevent penetration by the split spoon, samples may be collected from the auger flights. Slowly remove the auger and collect the sample at the point corresponding to the required depth. Samples collected in this manner must be documented on the boring log. Sample logging is described in Section 5.5.

Photographs of specific geologic features or sample location may be required for documentation purposes. A scale or item providing a size perspective should be placed in each photograph. The frame number and picture location shall also be documented in the field book. All equipment will be decontaminated following RETEC SOP 120 between sample locations and sample depths unless otherwise specified in the project specific sampling plan.

Upon completion of the boring, backfill may be required. The backfill may consist of native material, hydrated bentonite chips/pellets, Portland cement/bentonite grout, or other low permeability material as specified in the project specific sampling plan. All applicable state/federal regulations concerning plugging of boreholes should be reviewed prior to the commencement of field activities.

5.5 Sample Logging

To ensure consistent descriptions of soil or rock material, the following criteria should be included on the sampling logs:

- Soil or rock type
- Depth ranges, recorded in feet
- Grain size
- Roundness
- Sorting
- Moisture
- Color
- Degree of oil contamination

- Remarks

Examples of soil types would be gravel, sand, silt, or clay. Soil types should be based on the Unified Soil Classification System (USCS). Figure 3 shows the USCS table. Examples of rock types include limestone, shale, claystone, siltstone, and sandstone. Soil/rock classifications determined in the field may be subject to change based upon laboratory tests. Factors to consider before changing a field determination include the expertise of the field geologist/engineer and laboratory personnel, representative character of the tested sampling, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report.

Grain size, roundness, and degree of sorting should also be included on the log if they are discernable. In addition to composition, blow counts and the length of the sample recovered should also be recorded on the sampling log. The degree of sample moisture should be described as dry, moist, and wet.

The color(s) or range of color(s) of the soil or rock type should be defined. If a Munsell color chart is used, the number designation of the color will also be recorded in the description. A notation of the degree of oil contamination should be included on the sample log. The contamination should be noted as high (30 %), medium (10-30 %), low (1-10 %), or none. Other classifiers may include odor (low to high) and mottling (low to high).

Remarks should include anything pertinent to the sample description or sample collection that is not described above. Other information to be placed on the logs as appropriate is:

- PID readings (with associated calibration information)
- Appearance of contamination (consistency)
- Degree of fracturing or cementation in the rock
- Drilling equipment used (rod size, bit type, pump type, rig manufacturer and model, etc.)
- Special problems and their resolution (hole caving, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, lost casing, etc.)

Dates for start and completion of borings

- Depth of first encountered free water
- Definitions of special abbreviations used on log

5.6 Sample Handling

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with RETEC SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination. A representative sample will be placed in the sampling container. Sample containers (jars or bags) shall be labeled with the following information:

- Client or project name, or unique identifier, if confidential
- Unique sample description (i.e., test pit, boring, or sampling point number and horizontal/vertical location)
- Sample collection date and time
- Sampler's name or initials
- Analyses to be performed

These data shall be recorded on the field logs and/or field book. Larger bulk samples shall be placed in cloth bags with plastic liners or plastic five-gallon buckets. Sample bags shall be marked with the information listed above.

6.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 20 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project specific sampling plan.

7.0 Documentation

Documentation may consist of all or part of the following:

- Test pit or boring log
- Sample log sheets
- Field log book
- Chain-of-custody forms
- Shipping receipts
- Health & Safety forms (Job Hazard Analysis, Safety Task Analysis Review, and/or Site Specific Health & Safety Plan amendments)
- PID calibration records

All documentation shall be placed in the project files and retained following completion of the project.

8.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA/600/4-89/034, published by National Water Well Association, 1991.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies, EPA/600/R-92/128, published by the Environmental Research Center, 1992.

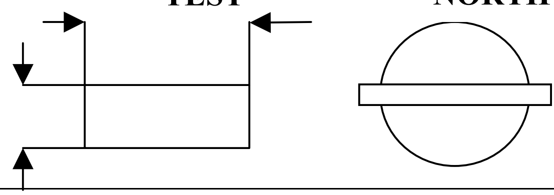
The RETEC Group
Test Pit Log

TEST PIT: TP-
SHEET:

PROJECT:		LOCATION:	CONTRACTOR:
PROJECT NO.:		EQUIPMENT USED:	
DATE:		TOTAL DEPTH (ft.):	
START TIME:	FINISH TIME:	LOGGED BY:	

Depth Range	Sample Type and Number	USCS	Depth (ft.)	Soil and Rock Description and Comments
			1	
			2	
			3	
			4	
			5	
			6	
			7	
			8	
			9	

TEST NORTH



Groundwater		
Date	Time (hours after completion)	Depth (ft.)

Comments:

The RETEC Group	BORING LOG	BORING SHEET OF

PROJECT	CONTRACTOR	MONUMENT
PROJECT #	DRILLER	RISER
LOCATION	RIG TYPE	SCREEN
TOTAL DEPTH	METHOD	FILTER PACK
DATE	CASING ID	SEAL
START FINISH	BORING ID	GROUT
LOGGED BY DMS	BIT TYPE	GROUND ELEV.

SAMPLE TYPE AND NUMBER	BLOWS PER 6 INCH	DEPTH RANGE	% REC	DEPTH FEET	SAMPLE DESCRIPTION CLASSIFICATION SCHEME___

GROUNDWATER DEPTH (FT)	DATE/TIME
REMARKS	

FIELD GUIDE AND USCS CLASSIFICATION TABLE

SAND

SOIL TYPE	SPT, N Blows/ft.	Relative Density, %	FIELD TEST
VERY LOOSE SAND	4	0 – 15	Easily penetrated with ½ " reinforcing rod pushed by hand.
LOOSE SAND	4 – 10	15 – 35	Easily penetrated with ½ " reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 – 30	35 – 65	Penetrated a foot with ½ " reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 – 50	65 – 85	Penetrated a foot with ½ " reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 – 100	Penetrated only a few inches with ½ " reinforcing rod driven with 5-lb hammer.

CLAY

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF) TORVANE	Unconfined Compressive Strength (PSF) Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and fingers when squeezed in hand.	<2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 – 4	250 – 500	500 – 1000
MEDIUM STIFF	Can be penetrated over ¼ " by thumb with moderate effort. Molded by strong finger pressure.	4 – 8	500 – 1000	1000 – 2000
STIFF	Indented about ¼ " by thumb but penetrated only with great effort.	8 – 15	1000 – 2000	2000 – 4000
VERY STIFF	Readily indented by thumbnail.	15 – 30	2000 – 4000	4000 – 8000
HARD	Indented with difficulty by thumbnail.	>30	>4000	>8000

Unified Soil Classification System (USCS)

		MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS		> 300	> 11.8	-
COBBLES		75 – 300	2.9 – 11.8	-
GRAVEL	COARSE	75 – 19	2.9 - .75	-
	FINE	19 – 4.8	.75 - .19	¾ " – No. 4
SAND	COARSE	4.8 – 2.0	.19 - .08	No. 4 – No. 10
	MEDIUM	2.0 - .43	.08 - .02	No. 10 – No. 40
	FINE	.43 - .08	.08 - .003	No. 40 – No. 200
FINES	SILTS	< .08	< .003	< No. 200
	CLAYS	< .08	< .003	< No. 200

Table Title

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL – GRADED GRAVELS, GRAVEL – SAND MIXTURES, LITTLE OR NO FINES.
			GP	POORLY – GRADED GRAVELS, GRAVEL – SAND MIXTURES, LITTLE OR NOT FINES.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND – SILT MIXTURES.
			GC	CLAYEY GRAVELS, GRAVEL – SAND – CLAY MIXTURES.
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)	SW	WELL – GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
			SP	POORLY – GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES)	SM	SILTY – SANDS, SAND – SILT MIXTURES
			SC	CLAYEY SANDS, SAND – CLAY MIXTURES.
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY, CLAYS, LEAN CLAYS.
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SITLS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS.
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS.

RETEC Standard Operating Procedure (SOP) 220
Monitoring Well Construction and Installation

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 220 establishes the method for installing observation standpipes or monitoring wells. These wells are installed to determine the depth to groundwater, monitor groundwater fluctuations, and/or obtain samples of groundwater for laboratory testing. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

It is the responsibility of the project geologist/engineer to directly supervise the construction and installation of each monitoring well by the contract driller to ensure that the well installation specifications outlined in the project plan are adhered to and to record all pertinent data on the approved forms. The project geologist/engineer will also be responsible for ensuring that all applicable permits and registrations are obtained prior to and after construction by RETEC, the contract driller, or other responsible party.

3.0 Supporting Materials

The list below identifies types of equipment which may be used for the construction and installation of the monitoring wells. The requirements for screen/riser pipe (length, gauge, and type), sand, bentonite/grout, and material manufacturers shall be addressed in the project specific sampling plan.

Materials to be provided by the contract driller include:

- Drill rig
- Decontamination equipment (e.g., steam cleaner, high-pressure cleaner, buckets, brushes, etc.)
- Weighted calibrated tape
- Screen/riser pipe with flush-threaded couplings including riser and bottom caps (e.g., PVC, fiberglass, galvanized, or stainless steel)
- Clean, silica sand
- Bentonite chips, pellets, or powder
- Cement grout, grout tub, grout pump, and tremie pipe
- Cement for protective pad

- Locking steel protective casing
- Miscellaneous items specified in the project plan (e.g., centralizers, sediment traps, bumper posts, containers for cuttings and fluids, etc.)

Materials provided by the geologist/engineer may include:

- Weighted calibrated tape
- Personal protective equipment
- Field book and field forms
- Camera

4.0 Methods And Procedures

Specific drilling, sampling, and installation equipment and methodology will be dictated by the geologic characteristics of the site, the types of contaminants being monitored, and local and state regulations.

4.1 Drilling

Drilling of the monitoring well borehole may be accomplished by a variety of methods. The hollow-stem, continuous flight auger is one of the most widely used methods for installing monitoring wells in unconsolidated soils. No drilling fluids are used and the disturbance to geologic materials penetrated is minimal. Solid-stem, continuous flight auger use is limited to consolidated sediments or to fine grained unconsolidated sediments. Augering methods are limited to boreholes less than 150 feet deep. The cable tool method is useful in relatively shallow unconsolidated and consolidated formations. Disadvantages to this method are that water must be used until the water table is reached, soil samples at depth are not easily obtainable, and it is very slow. Rotary methods use air or fluids during the drilling process to maintain an open hole and to remove cuttings. Clean water must be used for water-rotary drilling and care must be taken with mud-rotary techniques so that the drilling muds do not affect collection of representative groundwater samples.

In most projects, air rotary methods will be used in dense formations and augering will be used in loose formations. Soil sampling will be performed at the appropriate depth by removing the solid-stem auger or rotary-drill stem, or by sampling within the hollow-stem auger. All drilling and soil sampling procedures will be done in accordance with SOP 210. Prior to initiating drilling activities and between drilling locations and sampling depths, the drilling equipment will be cleaned and decontaminated in accordance with SOP 120.

4.2 Well Construction and Installation

In the case of rotary drilling, the borehole will be blown free of material prior to well installation. With hollow-stem augers, after the removal of the plug, the augers shall be raised approximately six inches above the bottom of the borehole, rotated slowly and returned to the bottom of the hole to facilitate removal of all material within the auger.

Backfilling of the borehole with native cuttings or clean sand to the well screen tip elevation shall be required if the tip is to be above the bottom of the borehole. A heavy plumb bob or a calibrated tape shall be used to determine the depth of the boring and the depth to the top of the backfill.

The well screen and riser pipe shall then be assembled. The riser pipe/screen shall be connected by flush-threaded joints. No solvent or anti-seize compound shall be used on the joints. The length of the screened area and the gauge of the screen or slots shall be determined by the inspecting geologist depending upon the grain-size distribution of the sediments. The assembled screen and riser, or its constituent parts, shall be steam cleaned prior to installation. The riser and screen shall be carefully placed in the borehole to ensure that it is centered in the hole and is true, straight, and vertical throughout. Centering can be accomplished with well centralizers.

The annular space surrounding the screened section of the monitoring well and two feet above the top of the screen shall be filled with clean silica sand. The well screen shall have a bentonite seal placed on top of the sand. The bentonite seal shall be approximately two feet thick to prevent vertical flow within the boring from affecting the screened area.

The remaining length of the borehole shall be backfilled or tremmied with grout to within two feet of the ground surface. This grouting may consist of a bentonite/cement mixture made to required specification. The steel guard-pipe shall be placed around the riser. “Weep” holes will be drilled in the riser and the guard-pipe at separate locations. The borehole around the guard-pipe shall be dug out to a depth of two feet and a one foot radius which will be filled with concrete. Bumper posts may be necessary depending upon the location of the well. All completed wells will have identification numbers clearly painted on the cap and guard pipe with bright colored paint.

4.3 Telescoping Well Construction

On sites where the presence of Non-Aqueous Phase Liquids (NAPLs) is of concern or the groundwater between different aquifers is to be isolated, the construction of telescoped wells may be necessary. This method allows the construction of monitoring wells which prevent inter- aquifer fluid mixing or the vertical displacement of NAPL. Situations which may require telescoped wells include the construction of wells into aquifers hydro-stratigraphically below impacted aquifers or simply the construction of wells through a perched aquifer without creating a vertical hydraulic conduit.

Similar to conventional wells, construction of telescoped wells can be accomplished using a variety of drill rig types including hollow-stem auger, air-rotary, and mud-rotary rigs. Telescoping well construction is initiated by “keying” a large diameter, outer steel casing into a stratigraphic horizon of low-permeability at the base of the upper impacted aquifer. Typically, the boring for the outer casing should be two-inches greater than the outside diameter of the inner casing to allow sufficient annular space for tremmie or pressure grouting (discussed below). The boring should extend a minimum of 18 inches, if possible, into the keying horizon to ensure an adequate seal. The boring should never breach the keying horizon under any circumstances. Once the boring is completed the casing can be set in one of two ways. The casing may be placed to the bottom of the boring, or the casing can be depressed with the drill rig about six-inches beyond the total depth of the boring. The latter should only be done if it is known that depressing the casing will not breach the keying horizon.

The drill rig must be capable of hoisting sections of large-diameter steel casings (standard casing length is 21 feet). If more than one section of casing is required, the driller must also have welding capabilities for connecting casing sections. Multiple section casings must be welded straight, otherwise the casing string will not reach to the bottom of the boring. Also, borings which are drilled too fast, can "corkscrew." Such borings will not accept long casing strings.

Grouting of the casing should be done by either tremmie-grouting or pressure-grouting the annular space inside of the casing to expel any fluids which could be vertically displaced into the lower aquifer(s). The grout should then be allowed a minimum of 24-hours to cure. Once the grout is cured, a smaller diameter drill pipe is used to bore through the grout to facilitate placement of a monitor well at the desired depth. The well is then constructed as described in Section 4.2. If another casing is necessary to seal an additional aquifer (triple-cased well), the outer casing is drilled out to the next keying horizon and process is repeated.

4.4 Drilling Fluids and Cuttings

If drilling fluids are used, no chemical additives will be mixed into the fluid to alter viscosity or lubricating properties. Fresh water for drilling will be obtained from a source not impacted by site contaminants (e.g., municipal water supply). A sample of the fresh water will be collected during the course of well installation and analyzed for parameters defined for the groundwater samples.

Spent fluids, if used, and cuttings will be contained and disposed of in a manner consistent with the project specific sampling plan.

4.5 Decontamination

Equipment and tools used during drilling activities will be cleaned prior to work startup. If the pre-drilling inspection reveals the presence of contamination such as visible chemical residue, an additional decontamination will be conducted to remove the residue. All equipment and tools used during drilling will be cleaned prior to leaving the site. Cleaning of drilling equipment and tools will comply with the procedures detailed in SOP 120.

5.0 Quality Assurance/Quality Control

Not applicable.

6.0 Documentation

A series of measurements shall be taken during the installation of each monitoring well. These measurements shall include:

- Screen length
- Riser pipe length
- Total well depth
- Depth to stabilized water level.

Other data include type and length of casing, diameter of the respective components, thickness and different types of filter pack and grouting materials, and elevation of the top of the guard pipe and ground surface after surveying is complete. All data shall be recorded on site onto the groundwater monitoring well completion form (Figure 1). All wells shall be surveyed and referenced onto the appropriate site map. A field book and/or boring log can be used as other means of recording data. All documentation shall be kept in the project files.

7.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

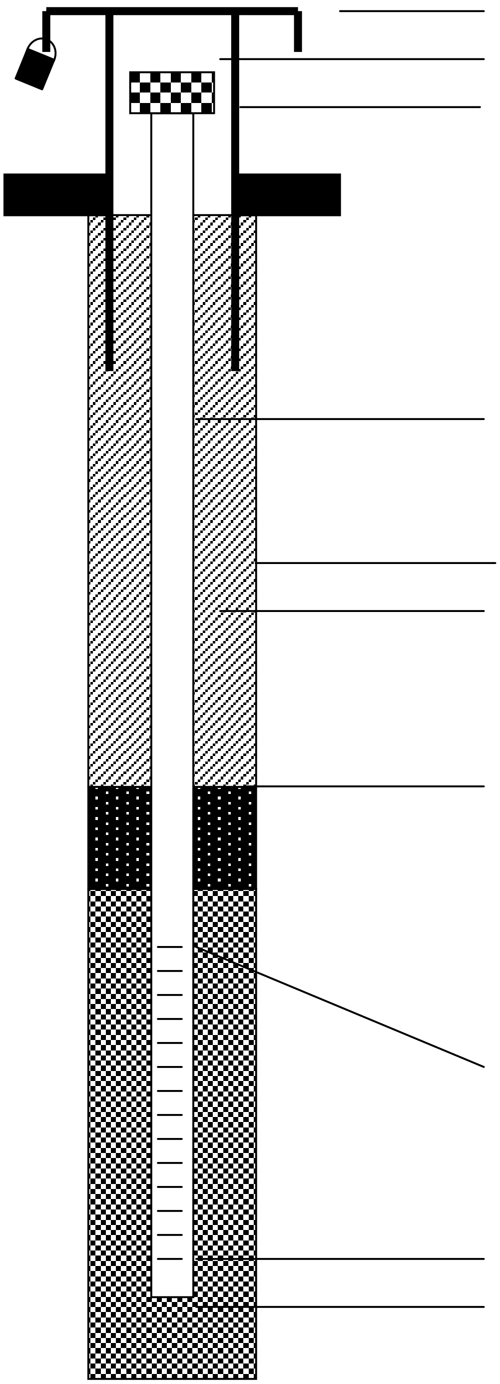
The RETEC Group

Well Completion Log

Date of Installation____________________ Monitoring Well No.____________________

Drilling Company____________________

Field Engineer____________________



Elevation of Top of Protective Casing____________

Elevation of Top of Riser Pipe____________

I.D. of Protective Casing____________

Type of Protective Casing____________

Ground Surface Elevation____________

I.D. of Riser Pipe____________

Type of Riser Pipe____________

____

Diameter of Borehole____________

Type of Backfill____________

____

Grout Ratio____________

Depth to Top of Seal____________

Type of Seal____________

____

Depth to Top of Sandpack____________

Type of Sandpack____________

____

Depth to Top of Screen____________

I.D. of Well Screen____________

Type of Well Screen____________

____

Depth to Bottom of Screen____________

Depth to Bottom of Sediment Trap____________

Depth to Bottom of Borehole____________

Groundwater Levels

Initial During Drilling____________

Upon Completion of Well________

RETEC Standard Operating Procedure (SOP) 221
Groundwater Well Development

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) Standard Operating Procedure (SOP) 221 describes the method for developing groundwater monitoring wells. Well development is the process of cleaning the face of the borehole and the formation around the outside of the well screen to permit groundwater to flow easily into the monitoring well.

Monitoring wells must be developed for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole to permit the water to flow into the screen easily
- To remove the clay, silt, and other fines from the formation so that during subsequent sampling the water will not be turbid or contain suspended matter which can easily interfere with chemical analysis
- To remove any contamination or formation damage that may have occurred as a result of well drilling

Well development is necessary for all newly completed wells and may be required for wells which have been left dormant for some time or have accumulated significant quantities of sediment in the well, gravel pack, or surrounding formation.

Well development should remove clay particles deposited on the surface of the formation along with sufficient quantity of water to ensure the removal of fluids introduced into the formation during drilling or prolonged inactivity. The development process should also effectively loosen and remove finer particles from the formation matrix.

During any drilling process the side of the borehole becomes smeared with clays or other fines. This plugging action substantially reduces the permeability and retards the movement of water into the well screen. If these fines are not removed, especially in formations having low permeability, it then becomes difficult and time consuming to remove sufficient water from the well before obtaining a fresh groundwater sample because the water cannot flow easily into the well. Existing wells may also require development due to the buildup of sediments in the well or surrounding formation, or accumulation of excessive quantities of light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) in the well due to inactivity.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance/Quality Control Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The project geologist/engineer will have the responsibility to oversee and ensure that all monitoring well development is performed in accordance with the project specific sampling program. In addition, the project geologist/engineer must record all pertinent data on the approved forms or in the project field book.

3.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of monitoring well development applications. A project specific equipment list will be selected based upon project objectives, the depth to ground water, purge volumes, and well construction. Types of sampling methods and equipment are as follows:

- Surge block
- Air lift
- Bailers and bailer cord
- Pump (centrifugal, bladder, peristaltic) and discharge line
- Conductivity/temperature/pH meter(s)
- Water-level measurement equipment
- Field data sheets and field book
- Buckets and intermediate containers
- Paper towels or chemical-free cloths
- Decontamination materials

4.0 Methods and Procedures

Well development is accomplished by causing the natural formation water inside the well to move vigorously in and out through the screen. The suspended sediment is then removed from the well by bailing or pumping. Several techniques may be employed in developing a well. To be effective, all require reversals or surges in flow to avoid bridging by particles. These surges can be created by using surge blocks, air lifts, bailers, or pumps. The use of water other than the natural formation water is not recommended during well development. If water is added, the amount should be noted on the field forms or in the project field book. Water quality analyses should be conducted so that comparisons can be made with subsequent natural groundwater data.

Before developing the well, water depth, LNAPL or DNAPL depth (if present), and well depth will be measured using an electronic or mechanical device. If a measurable amount of LNAPL or DNAPL is detected, the well shall be bailed or pumped prior to development in an attempt to remove the material. This procedure should reduce the opportunity of LNAPL or DNAPL being forced back into the filter pack and formation during development. Approximately 10 well volumes (calculated from the length of the water column and the well casing diameter) should be removed from the well during development. The discharge from the well should be continuously monitored and development should be continued until a particulate free discharge is apparent and the field parameters (pH, conductivity, and temperature) have stabilized within 10 percent of the previous reading. Field parameters should be recorded on the well development record (Figure 1) after each volume is removed. All materials and equipment used in conjunction with development must be free of any contamination prior to use and all provisions made to prevent the introduction of contaminants during development. Well depths will be measured following development to determine whether sand or silt has accumulated in the well. If material has accumulated, it will be removed with a bailer.

Regardless of the method employed, any discharges from the well must be properly disposed of depending on the nature of the liquid removed from the well. Additionally, all materials and equipment placed into the well in conjunction with development must be free of any contamination prior to use. Decontamination procedures should be consistent with those described in RETEC SOP 120.

Surge Block

A surge block is a round plunger with pliable edges that will not catch on the well screen. For two-inch diameter wells, the surge block can be constructed of two aluminum plates 1.75 inches in diameter surrounding a thin section of neoprene rubber approximately 2 inches in diameter. The surge block assembly is lowered by hand down the well by connecting sections of one-half inch threaded PVC pipe. Once within the screen interval, the block is rapidly raised and lowered to agitate the water within the well.

If the surge block method is employed, development can be continued using a nitrogen driven bladder pump to evacuate the well. The bladder pump is lowered down the well and is connected to a section of teflon tubing. The nitrogen supply is turned on to activate the pump and discharge liquid from the well.

Air Lift

Compressed air pumped down a pipe inside the well casing can be used to blow water out of the monitoring well. If air is applied to the well intermittently and for short periods then the water is only raised inside the casing rather than blown out and will fall back down the casing causing the desired backwashing action. Finally, blowing the water out will remove the fines brought into the screen by the agitating action.

Considerable care must be exercised to avoid injecting air into the well screen. Such air can become trapped in the formation outside the well screen and alter subsequent chemical analyses of water samples. For this reason, the bottom of the air pipe should never be placed down inside the screen.

Another consideration is the submergence factor. Submergence is the feet of water above the bottom of the air pipe while pumping (blowing water out) divided by the total length of the air pipe. Submergence should be on the order of at least 20 percent.

Bailer

A bailer, sufficiently heavy so that it will sink rapidly through the water, can be raised and lowered through the well screen. The resulting agitation action of the water is similar to that caused by a surge block. The bailer, however, has the added advantage of removing the fines each time it is brought to the surface and emptied. Bailers can be custom-made for small diameter wells and can be hand-operated in shallow wells.

Pumping

Starting and stopping a pump so that the water is alternately pulled into the well through the screen and backflushed through the screen is an effective development method. Periodically pumping the waste will remove the fines from the well and permit checking the progress to ensure that development is complete.

5.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control Plan requirements include the stabilization of field parameters to within 10 percent of the previous reading. A particulate free discharge is desirable but may not be possible based on the composition of the lithology in which the well is completed.

6.0 Documentation

Field parameter values shall be entered on the Well Development Form along with the corresponding purge volume. Additional observations, comments, and discussion concerning groundwater well development will be documented in the project field book or the development form. Copies of these documents will be placed in the project files and retained following completion of the project.

7.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

CRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

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Groundwater Well Development Record

Project:________________________________ **Well No.**________________________________

Date:________________________________ **Time:**________________________________

Well Condition:____________________________ **Developed By:**____________________________

1. Water Level Measurement and Well Purging
   a. Location of Measuring point ____________________________
   b. Depth of water table from measuring point ____________________________
   c. Height of measuring point above ground surface ____________________________
   d. Total depth of well below measuring point ____________________________
   e. Length of water column (line 2d-2b) ____________________________
   f. Development method ____________________________
   g. Evacuated volume

Pumping Duration / Vol Rmvd.	pH	Cond.	T(C)	Appearance

2. Comments:

MONITORING WELL DEVELOPMENT LOG

RETEC

Site:	Client:
Project No.:	Sample ID:	Well No.:
Development Start Date/Time:	Development End Date/Time:
Developed By:	

Depth Measurement Ref. Point* ____________ Well Casing ID: 2" 4" 6" Other _____

Well Headspace/Odor ____________________ LNAPL Check (Yes/No) DNAPL Check (Yes/No)

Equipment used to measure thickness and sample free product (Make, Model, etc.) ____________

Depth to top and bottom of screened interval ____________ Depth to LNAPL ____________

Original DTW ____________ Final DTW ____________ Depth to DNAPL ____________

LNAPL/DNAPL Thickness ____________ LNAPL/DNAPL Sample and Volume ____________

Measured Well TD: ____________ (-) Original DTW: ____________ (=) Ht. Wtr Col.: ____________

DEVELOPMENT METHOD:

- ☐ Submersible Pump ☐ Dedicated Bladder Pump ☐ Bladder Pump ☐ SS
- ☐ Centrifugal Pump ☐ Peristaltic Pump ☐ Hand Pump ☐ Bailer ☐ Tef
- ☐ Gas Lift/Displacement Pump ☐ Inertial Lift Pump ☐ Other ____________ ☐ PVC

Development Equip. (Make, Model, etc.) ____________

Development Water Containerized? (Yes / No) Development Equip. Decontaminated? ☐ Yes ☐ No

Average Development Rate: ____________ gpm Weather ____________

Actual Time (min.)	Vols. Purged (gals.)	Depth to Pump Intake (ft.)	Depth to Water (ft.)	Temp (^oC)	pH	Cond. (mS/cm)	Turbidity (NTA)	D.O. (mg/L)	Salinity (%)	Comments

* All depths in feet below reference point on wellhead, generally Top of Casing; DTW = Depth to Water; LNAPL/DNAPL = Light/Dense Non-Aqueous Phase Liquid

RETEC Standard Operating Procedure (SOP) 230 Groundwater Sampling

1.0 Purpose and Applicability

This SOP describes the collection of valid and representative samples from groundwater monitoring wells. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have the responsibility to oversee and ensure that all groundwater sampling is performed in accordance with the project specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Supporting Materials

The list below identifies the types of equipment which may be used for a range of groundwater sampling applications. From this list, project specific equipment will be selected based upon project objectives and site conditions (e.g., the depth to groundwater, purge volumes, analytical parameters, well construction, and physical/chemical properties of the analytes). The types of sampling equipment are as follows:

- Purging/Sample Collection
  - Bailers and bailer cord
  - Centrifugal pump
  - Bladder pump or Peristaltic pump

The most widely applicable equipment that will contact the water must be made of inert materials, preferably stainless steel or fluorocarbon resin.

- Sample Preparation/Field Measurement
  - pH meter
  - Specific conductance meter
  - Thermometer
  - Filtration apparatus
  - Water-level measurement equipment

All equipment will be calibrated before use following the manufacturer's specifications.

- General
  - Distilled water dispenser bottle
  - Methanol or isopropyl dispenser bottle
  - Decontamination equipment
  - Personal protection equipment as specified in the Project Health and Safety Plan
  - Field data sheets and field book
  - Sample containers, labels, and preservation solutions
  - Buckets and drums
  - Coolers and ice
  - Paper towels or chemical-free cloths

4.0 Methods And Procedures

The following sections describe the methods and procedures required to collect representative groundwater samples.

Water-Level Measurement

After unlocking and/or opening a monitoring well, the first task will be to obtain a water- level measurement. A static-water level will be measured in the well prior to the purging and collection of any samples. The water level is needed for estimating the purge volume and may also be used for mapping the potentiometric surface of the groundwater. Water-level measurements will be made using an electronic or mechanical device following the methods described in SOP 231.

Measurement of point location for the well should be clearly marked on the outermost casing or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If not marked from previous investigations, the water level measuring point should be marked on the north side of the well casing and noted in the groundwater sampling form (Figure 1). Whatever measuring point is used, the location should be described on the groundwater sampling form.

To obtain a water level measurement lower a decontaminated mechanical or an electronic sounding unit into the monitoring well until the audible sound of the unit is detected or indicates water contact. At this time the precise measurement should be determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement. The water-level measurement should be entered on the groundwater sampling form. The water-level measurement device shall be decontaminated immediately after use following the procedures outlined in SOP 120.

Purging and Sample Collection Procedures

Well purging is the activity of removing some volume of water from a monitoring well in order to induce “fresh” groundwater to flow into the well prior to sampling. Under most well construction and hydrogeologic conditions, this provides water that is more representative of the groundwater in saturated materials adjoining the well.

The volume of water to be removed, referred to as the purge volume, is a function of the water- yielding capacity of the well, the well diameter and depth, and the depth to water made just prior to purging. The well depth should be sounded with the water-level cable or tape just before or after measuring the static depth to water. A well volume is defined as the product of the length of water column and the volume per unit length of well casing, a function of casing inside diameter. The following data can be used in this field calculation:

Inside Diameter, inches	**Gallons/foot**
1 1/4	0.077
1 1/2	0.10
2	0.16
3	0.37
4	0.65
6	1.64

According to the TEGD (USEPA, 1986), the purge volume should equal at least three well volumes when the earth materials will yield relatively large quantities of water, and between one and two well volumes when the earth materials will only yield small quantities to the well. From a field operations viewpoint, large quantities (high yield) means that the well can not be pumped or bailed “dry” by removing three well volumes. Small quantities (low yield) are identified when the well can be pumped or bailed “dry”.

Based on experience and recent scientific literature, it will be The RETEC Group, Inc. (RETEC) policy to minimize the generation of water turbidity when purging. Turbidity is especially of concern when testing the samples for metals or for selected organics that may be sorbed to the sediment. Turbidity will be minimized by :

- Using a low-pumping rate submersible pump such as a compressed- gas driven bladder pump
- Slowly moving the bailer in and out of the water column; avoid dropping the bailer and removing it quickly

Purging will be performed for all groundwater monitoring wells prior to sample collection.

Three general methods are used for well purging. Well purging may be achieved using bailers, surface pumps, or down-well submersible pumps. In all cases pH and specific conductance will be monitored during purging. Field parameter values will be entered on the groundwater sampling form along with the corresponding purge volume. The following sections explain the procedures to be used to purge and collect samples from monitoring wells.

4.2.1 Bailing

Obtain a clean decontaminated bailer and a spool of polypropylene rope or equivalent bailer cord. Using the rope at the end of the spool, tie a bowline knot, or equivalent, through the bailer loop. Test the knot for adequacy by creating tension between the line and the bailer. Tie again if needed.

Lower the bailer to the bottom of the monitoring well and remove an additional five feet of cord from the spool. Cut the cord at the spool and secure the rope to the well head or the wrist of the person who shall perform the bailing.

Raise the bailer by grasping a section of cord using each hand alternately. This bailer lift method is used so that the bailer cord will not come into contact with the ground or other potentially contaminated surfaces.

Samples collected by bailing will be poured directly into sample containers from bailers which are full of fresh groundwater. Samples will be collected in the following order:

- Volatile organic compounds
- Semivolatile organic compounds
- Pesticides/Herbicides/PCBs/Dioxins
- Organic indicator compounds
- Metals (total and/or dissolved)
- Miscellaneous inorganic compounds
- Radiometric compounds
- Microbial analyses

During sample collection, bailers will not be allowed to contact the sample containers.

4.2.2 Pumping

Groundwater withdrawal using pumps is commonly performed with centrifugal, peristaltic, submersible, or bladder pumps. Peristaltic and centrifugal pumps are limited to conditions where groundwater need only be raised through approximately 20 to 25 feet of vertical distance. Submersible or bladder pumps can be used when groundwater is greater than 25 feet below grade. Specific methods for pumps will be discussed in the project specific sampling plan. Pumping for collection of samples to be analyzed for volatile organics will only be with bladder pumps.

Samples collected by pumping will be transferred directly from the pump discharge tubing into the sample containers. Samples will be collected in the following order:

- Volatile organic compounds
- Semivolatile organic compounds
- Pesticides/Herbicides/PCBs/Dioxins
- Organic indicator compounds
- Metals (total and/or dissolved)
- Miscellaneous inorganic compounds
- Radiometric compounds
- Microbial analyses

During sample collection, the discharge tubing will not be allowed to contact the sample containers.

Sample Preparation and Filtration

Specific procedures pertaining to the handling and shipment of samples shall be in accordance with SOP 110. A clean pair of gloves and decontaminated sampling tools will be used when handling the samples during collection to prevent cross contamination.

Prior to transport or shipment, groundwater samples may require preparation and/or preservation. Field preparation may entail filtration, preservation in the form of chemical additives, or temperature control. Specific preservation requirements will be described in the project specific sampling plans.

Groundwater samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers. Groundwater filtration is performed using a peristaltic pump and a 0.45 micron water filter unless otherwise specified in the project specific sampling plan. For most dissolved metal analyses, pH adjustment of the sample is also required and shall be performed after filtration.

5.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) requirements include, but are not limited to, blind field duplicates, blind rinsate blanks, and blind field blanks. These samples will be collected on a frequency of one QA/QC sample per 10 field samples or a minimum of one QA/QC sample per day unless otherwise specified in the project specific sampling plan.

6.0 Documentation

Various documents will be completed and maintained as a part of Groundwater Sample collection. These documents will provide a summary of the sample collection procedures and conditions, shipment method, analyses requested, and the custody history. These documents may include:

- Field book
- Groundwater sampling forms
- Sample labels
- Chain-of-custody
- Shipping receipts

All documentation will be stored in the project files.

7.0 References

Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells, EPA 600/4-89/034, published by National Water Well Association, 1989.

RCRA Ground Water Monitoring Technical Enforcement Guidance Document, published by National Water Well Association, 1986.

A Compendium of Superfund Field Operations, EPA 540/P-87/001, published by the Office of Emergency and Remedial Response, Office of Waste Programs Enforcement, US EPA, 1987.

The RETEC Group

Groundwater Sampling Form

PROJECT ______________________________ WELL NO.______________________________
PROJECT NO. ______________________________ SAMPLERS______________________________

1. WELL CONDITION CHECKLIST:

a. Bump posts______________ Prot. casing/lock__________ Surface pad______________
b. Well visibility (paint)_______
c. Well label_______________

2. WATER LEVEL MEASUREMENT:

DATE______________________________ TIME______________________________
WEATHER CONDITIONS____

a. Location of measuring point ______________________________
b. Depth of water table from measuring point ______________________________
c. Height of measuring point above ground surface ______________________________
d. Total depth of well below measuring point ______________________________
e. Length of water column (line 2d-2b) ______________________________

3. WELL PURGING:

DATE______________________________ TIME______________________________
WEATHER CONDITIONS____

a. Purge method ______________________________
b. Required purge volume at 3 well volumes ______________________________

Pumping Duration	Volume Rmvd.	PH	Cond.	T(C)	Color	Turbidity

4. SAMPLE COLLECTION:

DATE______________________________ TIME______________________________
WEATHER CONDITIONS____

a. Collection method____
b. Meter calibration Date Model
pH meter ______________________________
Conductivity meter ______________________________
c. Sample information pH__________ Cond.________ T(C)_________ Turbidity_______

Analysis	Containers	Sample Prep./Preservation

d. Chain of custody form______________________ COC tape______________________
e. Shipping container____

5. COMMENTS:____
____
____

RETEC Standard Operating Procedure (SOP) 231
Water-Level Measurements

1.0 Purpose and Applicability

This SOP is concerned with the measurement of water levels in groundwater monitoring wells. Water-level measurements are fundamental to groundwater and solute transport studies. Water-level data are used to indicate the directions of groundwater flow and areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate stream-aquifer relations. Measurements of the static-water level are also needed to estimate the amount of water to be purged from a well prior to sample collection.

Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The field sampling coordinator will have the responsibility to oversee and ensure that all procedures are performed in accordance with the project specific sampling program and this SOP.

3.0 Supporting Materials

This section identifies the types of equipment which may be used for measurement of groundwater levels. Based on project objectives, observed or probable well contamination, and well construction, a project specific equipment list will be determined from the following equipment:

- Water-level and/or product-level measuring device
- Distilled water dispenser bottle
- Methanol or isopropyl dispenser bottle
- Plastic sheeting
- Personal protection equipment as specified in the Project Health and Safety Plan
- Fluid-level monitoring logs and field book
- Paper towels or chemical-free cloths

4.0 Methods And Procedures

When taking a series of fluid-level measurements at a number of monitoring wells, it is generally good practice to go in order from the least- to most-contaminated well. Additionally, the measurement of all site wells should be done consecutively and before any sampling activities begin. This will ensure the data are representative of aquifer conditions. All pertinent data should be entered in the fluid-level monitoring log sheet (Figure 1) or the project field book.

4.1 Well Evaluation

Upon arrival at a monitoring well, the surface seal and well protective casing should be examined for any evidence of frost heaving, cracking, or vandalism. All observations should be recorded in the fluid-level monitoring log or the project field book. The area around the well should be cleared of weeds and other materials prior to measuring the static-water level. A drop cloth or other material (e.g., plastic garbage bag) should be placed on the ground around the well, especially if the ground is disturbed or potentially contaminated. This will save time and work for cleaning equipment or tubing if it falls on the ground during preparation or operation. The well protective casing should then be unlocked and the cap removed.

4.2 Safety Considerations

If the well is suspected of being contaminated, or has a history of contamination, the static water-level measurements should be made while wearing appropriate protective gear. The air in the well head should be sampled for organic vapors using either a photoionization analyzer or an organic vapor analyzer. The results shall be recorded in the fluid-level monitoring log or the project field book. This is the first indication of the presence of a non-aqueous phase liquid (NAPL). If the potential for fire or explosion exists, additional personal monitoring shall be conducted.

4.3 Measuring Point Location

The measuring point location for the well should be clearly marked on the outermost casing or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If not marked from previous investigations, the water-level measuring point should be marked on the north side of the well casing and noted in the fluid-level monitoring log or the project field book. Monitoring well measurements for total depth and water level should be consistently measured from one reference point so that these data can be used for assessing trends in the groundwater.

4.4 Water-Level Measurement

Water-level measurements shall be made using an electronic or mechanical device. Several methods for water-level measurement are described below. The specific method to be used will be defined in the project specific sampling plan.

4.4.1 Graduated Steel Tape

The graduated steel tape method is considered an accurate method for measuring the water level in nonflowing wells. Steel surveying tapes in lengths of 100, 200, 300, 500, and 1,000 feet are commonly used; a black tape is better than a chromium-plated tape. The tapes are mounted on hand- cranked reels up to 500-ft lengths; for greater depth, a motor-driven tape drive is usually required. A slender weight is attached to the ring at the end of the tape to ensure plumbness and to permit some feel for obstructions.

The lower few feet of tape is chalked by pulling the tape across a piece of blue carpenter's chalk. The wet chalk mark identifies the portion of the tape that was submerged. Lower the graduated steel-tape from the measuring point at the top of the well until a short length of the tape is submerged. The weight and tape should be lowered into the water slowly to prevent splashing. Submergence of the weight and tape may temporarily cause the water level to rise in wells or piezometers having very small diameters. This effect can be significant if the well is in materials of very low hydraulic conductivity.

Under dry surface conditions, it may be desirable to pull the tape from the well by hand, being careful not to allow it to become kinked, and reading the water mark before rewinding the tape onto the reel. In this way, the water mark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. Read the tape at the measuring point, and then read the water mark on the tape. The difference between these two readings is the depth to water below the measuring point. Errors resulting from the effects of thermal expansion of tapes and of stretch due to the suspended weight of the tape and plumb weight can become significant at high temperatures and for measured depths in excess of 1,000 feet.

The observer should make two measurements. If two measurements of static-water level made within a few minutes do not agree within 0.01 or 0.02 foot in observation wells having a depth to water of less than a couple hundred feet, continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable. Where water is dripping into the well or covering the well casing wall, it may be impossible to get a good water mark on the chalked tape.

4.4.2 Electrical Methods

Many types of electrical instruments are available for water-level measurement; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Electrodes are generally contained in a weighted probe that keeps the tape taut while providing some shielding of the electrodes against false indications as the probe is being lowered into the well. Before lowering the probe in the well, the circuitry can be checked by dipping the probe in water and observing the indicator (a light, sound, and/or meter).

To obtain a water-level measurement, slowly lower the decontaminated probe into the monitoring well until the indicator (light, sound, and/or meter) shows water contact. At this time the precise measurement should be determined by repeatedly raising and lowering the tape or cable to converge on the exact measurement.

In wells having a layer of NAPL floating on the water, the electric tape will not respond to the oil surface and, thus, the fluid level determined will be different than would be determined by a steel tape. The difference depends on how much NAPL is floating on the water. Dual media tapes are recommended in these instance to measure both NAPL and water levels using the same measuring device.

Water-level measurement should be entered in the fluid-level monitoring log or the project field book. The water-level measurement device shall be decontaminated immediately after use following the procedures described in SOP 120.

4.4.3 Air Line

The air line method is especially useful in pumped wells where water turbulence may preclude using more precise methods. A small diameter air-type tube of known length is installed from the surface to a depth below the lowest water level expected. Compressed air is used to purge the water from the tube. The pressure, in pounds per square inch (psi), needed to purge the water from the air line multiplied by 2.31 (feet of water for one psi) equals the length in feet of submerged air line. The depth to water below the center of the pressure gage can be easily calculated by subtracting the length of air line below the water surface from the total length of air line (assuming the air line is essentially straight).

Accuracy depends on the precision to which the pressure can be read. The accuracy of an air line or pressure gage measurement depends primarily on the accuracy and condition of the gage. It is normally within one foot of the true level as determined by means of a steel-tape measurement. The air lines themselves, however, have been known to become clogged with mineral deposits or bacterial growth, or to develop leaks and consequently yield false information. A series of air line measurements should be checked periodically by the use of a steel tape or an electric water-level indicator.

The air line and any connections to it must be airtight throughout the entire length. A long-term increase in air line pressure may indicate gradual clogging of the air line. A relatively sudden decrease in air line pressure may indicate a leak or break in the air line. Air line pressures that never go above a constant low value may indicate that the water level has dropped below the outlet orifice of the air line. To minimize the effect of turbulence, the lower end of the air line should be at least five feet above or below the pump intake. Corrections should be made for fluid temperatures much different from 20 C and for vertical differences in air density in the well column for cases where the depth to water is very large.

4.5 Procedures for Immiscible Fluids

At those facilities where monitoring to determine the presence or extent of immiscible fluids is required, the sampler will need to use special procedures for the measurement of fluid levels. The procedures required will depend on whether light NAPL (LNAPL) that form lenses floating on top of the water table or dense NAPL (DNAPL) that sink through the aquifer and form lenses over lower permeability layers are present.

In the case of LNAPL, measurements of immiscible fluid and water level usually cannot be accomplished by using normal techniques. For example, a chalked steel tape measurement will only indicate the depth to the immiscible fluid (not the depth to water) and a conventional electric water- level probe will not generally respond to nonconducting immiscible fluids. Similar problems are found with other techniques.

To circumvent these problems, the use of special techniques and equipment can be specified. These techniques have been specially developed to measure fluid levels in wells containing LNAPL or DNAPL, particularly petroleum products. One method is similar to the chalked steel tape method. The difference is the use of a special paste or gel rather than ordinary carpenters chalk. Such indicator pastes, when applied to the end of the steel tape and submerged in the well, will show the top of the oil as a wet line and the top of the water as a distinct color change. Another method, similar to the electric tape method, uses a dual purpose probe and indicator system. The probe can detect the presence of any fluid (through the wetting effect) and can also detect fluids that conduct electricity. Thus, if a well is contaminated with low density, nonconducting LNAPL such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, electrical conduction will be detected. The detection of a DNAPL would be similar.

4.6 Measurement of Total Depth

During water-level measurement, the total depth of the well may also be measured. This measurement gives an indication of possible sediment buildup within the well that may significantly reduce the screened depth. The same methods used for measuring water levels (e.g., steel tape or electrical probes) may be used to measure the total well depth. The most convenient time to measure the total well depth is immediately following measurement of the water level and prior to removing the measurement device completely from the well. The measurement device (steel tape or electrical probe) is lowered down the well until the measurement tape becomes slack indicating the weighted end of the tape or probe has reached the bottom of the well. The total well depth shall be recorded in the field book.

5.0 Quality Assurance/Quality Control

To ensure that accurate data are collected, repeated measurements of the fluid depths should be made. The readings should be within 0.01 to 0.02 feet of each other. A secondary check, if data are available, is to compare previous readings collected under similar conditions (e.g., summer months, wells pumping, etc.).

6.0 Documentation

Data will be recorded in the fluid-level monitoring log form, the project field book, or, if groundwater sampling, the groundwater sample collection record. Additional comments, observations, or details will also be noted. These documents will provide a summary of the water-level measurement procedures and conditions, and will be kept the in project files.

The RETEC Group
FLUID-LEVEL MONITORING LOG

SITE LOCATION:	PROJECT NAME:
PERSONNEL:	PROJECT NO.:
GAUGING INSTRUMENT:	DATE(S):

WELL NUMBER	DATE	TIME	TOTAL DEPTH (a)	DEPTH TO WATER (a)	DEPTH TO NAPL (a)	NAPL THICKNESS	REMARKS

(a) Measured from surveyed measuring point, unless otherwise noted.
NAPL = Non-aqueous phase liquid

Figure 1

RETEC Standard Operating Procedure (SOP) 310
Jar Headspace Screening

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 310 describes the basic techniques for using a Jar Headspace analysis to screen for volatile organics from contaminated soils using a portable Photoionization Detector (PID) or Flame Ionization Detector (FID). Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The project sampling coordinator is responsible for overseeing work activities to ensure that field screening is performed and documented in accordance with the methods described here and in project specific sampling plan.

3.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper field analysis procedures may be followed.

- PID/FID instrument
- 16 oz. soil or "mason-type" glass jars
- Aluminum foil
- Project field book

4.0 Methods and Procedures

Half-fill one clean glass jar with the sample to be screened. Quickly cover each open top with one to two sheets of clean aluminum foil and apply screw caps to tightly seal the jars. Allow headspace development for at least ten minutes. Vigorously shake jars for 15 seconds, both at the beginning and end of the headspace development period. Where ambient temperatures are below 32 F (0 C), headspace development should be within a heated vehicle or building.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. As an alternative, use a syringe to withdraw a headspace sample then inject the sample into the instrument probe or septum-fitted inlet. This method is acceptable contingent upon verification of methodology accuracy using a test gas standard. Following probe insertion through foil seal and/or sample injection to probe, record highest meter response as the jar headspace concentration. Using foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be discounted.

5.0 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. Data generated between the duplicates should be consistent to plus or minus twenty percent. Also, the PID/FID instrument shall be calibrated (see SOP 320 for HNu operation/calibration) before beginning screening, and checked or recalibrated not less than once every ten analyses.

6.0 Documentation

All data generated (results and duplicate comparisons) will be recorded in the field book. Any deviation from the outlined procedure will also be noted. Field conditions (ambient temperature, wind, etc.) should also be recorded in the field notebook.

RETEC Standard Operating Procedure (SOP) 410 Quality Assurance/Quality Control Data Validation

1.0 Purpose and Applicability

The RETEC Group, Inc. (RETEC) SOP 410 describes the method to be used for evaluating analytical laboratory data collected during field investigations. This evaluation is performed in order to establish the validity of the data generated. The laboratory analytical data will be evaluated for precision, accuracy, and completeness. Specific project requirements as described in an approved Work Plan, Sampling Plan, Quality Assurance Project Plan, or Health & Safety Plan will take precedence over the procedures described in this document.

2.0 Responsibilities

The project manager will be responsible for ensuring that procedures set forth in the sampling program documents are followed in the field, and in the analytical laboratory. Where procedures differ, the most stringent project-specific document(s) will apply.

The Project Quality Assurance/Quality Control (QA/QC) Officer will be responsible for validating the analytical data for precision, accuracy, and completeness. The QA/QC Officer will work in conjunction with the project manager and Laboratory Coordinator to produce the final report.

3.0 Supporting Materials

Section 3.0 is not applicable.

4.0 Methods and Procedures

This section presents the method and procedure for implementation of the RETEC Quality Assurance/Quality Control process for data evaluation. Analytical data will be reviewed for precision, accuracy, and completeness. The following sections provide a detailed discussion of the steps necessary to meet these criteria. The following criteria are recommended and should be evaluated on a project-specific basis.

A preliminary evaluation of the analytical data will include:

- Review of the Work Plan or Quality Assurance Project Plan (QAPP)

- A review of the laboratory project narrative
- A review of holding times, detection limits, methods of analysis
- A check of data flags, reporting units, and sample matrices

Any deviations from the requirements of the QAPP will be identified in the data evaluation report and the Project Manager will be notified. Additionally, the laboratory will be contacted, if necessary, and appropriate corrective actions will be implemented.

4.1 Evaluation Of Precision

Precision is the measure of variability of individual sample measurements. Precision is determined through the analysis of replicate samples, field blanks, trip blanks, and equipment rinseate blanks. A replicate sample represents two or more separate samples collected at the same location. A replicate sample is often referred to as a duplicate. Additionally, replicates are often submitted to the laboratory as blind samples. Field blanks consist of deionized water poured into sample bottles in the field. These blanks are used to determine whether airborne contamination is present at the site. Trip blanks are laboratory generated analyte-free water samples for volatiles analysis which travel to and from the site with the sample coolers. These blanks are used to document contamination attributed to bottle preparation and/or shipping and handling procedures. Equipment rinseate blanks consist of reagent water exposed directly to sampling equipment. The equipment rinseate blank is useful in documenting adequate decontamination of sampling equipment.

4.1.1 Duplicates

Duplicates, when collected, will be evaluated at the frequency of ten percent (10%) of samples collected for each matrix. Evaluation of replicates for precision will be done using the Relative Percent Difference (RPD). The RPD is defined as the difference between two duplicate samples divided by the mean and expressed as a percent. The RETEC advisory limit for RPDs is 50% for soil samples and 30% for groundwater. When the RPD exceeds the advisory limit, consideration will be given to the possibility of matrix effect. If however professional judgment indicates a potential laboratory error, the positive results will be “J” flagged.

4.1.2 Field Blanks

Collection of a field blank is recommended for one in every 20 samples, or one sample per batch if less than 20 samples are collected. However, on a project-specific basis, analysis of field blanks may not be appropriate.

4.1.3 Trip Blanks and Rinseate Blanks

Preparation of a trip blank is recommended at one blank for each cooler if volatile analysis has been requested. Equipment rinseate blanks should be collected during each day of sampling or at a 10% frequency.

4.2 Evaluation of Accuracy

The accuracy of data is a measure of the system bias. The level of accuracy is determined through examination of a Blank Spike (BS), laboratory Matrix Spike/Spike duplicate analyses (MS/MSD), surrogate recoveries for organic analyses, and method blanks. A blank spike is a laboratory QC sample which is introduced with the sample batch to monitor the performance of the system. The BS is used to document laboratory performance and is also referred to as a Lab Control Sample (LCS), Ongoing Precision Recovery (OPR), or Lab Spike (LS). The MS/MSD is an environmental field sample which is spiked with method or client specific analytes. The MS/MSD indicates how well the lab can reproduce the analytical results on field samples. The MS/MSD can indicate matrix effects. Surrogates are compounds that are structurally similar to the compounds requested for analysis, but are not found in nature (i.e., deuterated compounds). They are analyzed to demonstrate the percent recovery of the method by the laboratory and are applicable only for organic analysis. Method blanks or reagent blanks are analyte-free blank samples which monitor contamination introduced by the laboratory during sample preparation or analysis.

Blank spikes are recommended for one in every twenty sample analyses. A MS/MSD set is recommended for one in every twenty samples. Surrogates are compounds spiked into every sample submitted to the laboratory for organic analysis and have method specific recovery limits. A method blank will be prepared for one in every 20 samples per matrix. Method blanks are used to check on process contamination, carry over, and purity of reagents used by the laboratory.

When a BS is outside of the control limits, the laboratory should first re-analyze the sample. If it is still outside of the control limits, the laboratory should then re-extract all samples in the set. If neither of the above has been done by the laboratory, then all of the data should be qualified with either a “J”, indicating that the values are estimates, or an “R” which indicates that the results are unusable. The severity of flagging will be based on the professional judgment of the data reviewer and the ultimate use of the data.

MS/MSD percent recoveries and RPDs are compared to published QC limits. If the MS/MSD recoveries and/or RPDs are outside QC limits, but the BS recovery is acceptable, the samples likely have matrix interference problems. If the precision is acceptable between the MS and the MSD, then the reliability of the data is good. If the recovery in the MS or MSD is less than 10%, the corresponding unspiked sample should be qualified with a “J” for positive hits, and an “R” for non-detected results. Note that this action is taken on the sample alone, not the entire batch of samples.

When surrogate recoveries are outside QC limits, procedures described below will be followed:

- If one Base/Neutral (B/N) and/or one Acid surrogate is outside of the QC limits, and the surrogate recoveries are all greater than 10%, the positive results should then be estimated as “J” while the non-detected results should be estimated as “UJ”.
- If two Base/Neutral (B/N) or two Acid surrogates (or more) are outside of the QC limits, or surrogate recovery is less than 10%, the sample should then be re-analyzed.
- If a volatile surrogate is out of QC limits, the sample should be re-analyzed.
- After the laboratory has re-analyzed the surrogates are they still outside of the QC limits, both results should be reported and the outlying recoveries attributed to matrix interference.
- If the laboratory does not re-analyze or re-extract and re-analyze, then the positive results should be flagged with a “J” and the non- detected results flagged with an “R”.
- If the surrogates are outside of the QC limits for any blank, then validity of the data should be considered questionable.

4.3 Evaluation of Completeness

Completeness is a measure of the amount of data actually collected, analyzed, and validated compared to the amount specified in the sampling plan. The overall measure of completeness is the ratio of samples planned to valid analyses received. The data quality objective for the data is to achieve 90-100% accuracy and completeness of data collected, unless otherwise stated in the QAPP.

5.0 Quality Assurance/Quality Control

RETEC will review all data validation procedures on a yearly basis and update OA/QC procedures annually if necessary.

6.0 Documentation

During the data review/validation process, problems with analytical procedures, analytical results outside QC limits, or other unusual conditions will be documented.

In many cases this information will be contained in the laboratory project narrative accompanying the analytical data. Where additional explanations from the laboratory are required, the information will be documented by the laboratory and provided to RETEC. The QA/QC Officer will summarize the information for inclusion into the QA/QC summary. Documentation of data review/validation will vary depending upon the level of review required by the individual project.

7.0 References

Analyses, EPA (1990)

CLP Organic Data Review, EPA (1992)

EPA Contract Laboratory Program (CLP) Guidelines:
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Test Methods for Evaluating Solid Waste, SW-846, Third Edition (1993)